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EFFECTS OF EXPLICIT TIMING ON MATHEMATICS PROBLEM COMPLETION RATES IN AFRICAN-AMERICAN THIRD-GRADE ELEMENTARY STUDENTS

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A multiple baseline design was used to evaluate the effects of Van Houten and Thompson's (1976) explicit timing procedure on problem completion rates and accuracy levels in African-American third-grade students. During the explicit timing phase, students were told that they were being timed and were instructed to circle the last problem completed at each 1-min interval. Results showed that the explicit timing procedure increased problem completion rates. A decreasing trend in percentage of problems correct also occurred. Exploratory data analysis suggested that decreases in accuracy were not caused by the explicit timing procedure and did not occur in students who had attained high levels of preintervention accuracy. Discussion focuses on recommendations for educators who wish to use timing procedures to increase students' rates of accurate responding.

DESCRIPTORS: timing, rates of responding, African-American students

According to Haring and Eaton (1978), after students acquire a skill, the next step towards skill mastery is to improve fluency or rates of accurate responding. Independent seat work is often used to improve students' mathematics computation fluency. Researchers have shown that increasing students' rate of academic responding during independent seat work can increase students' computation performance (Van Houten & Little, 1982) and learning rates (Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997). Timing students is one way to increase rates of responding during independent seat work. Van Houten and Thompson (1976) used an explicit timing procedure to increase problem completion rates in academically challenged second-grade students. During baseline phases, students were given assignment sheets and were told to complete as many problems as possible. During intervention phases, students were told they had 30 min to complete as many problems as they could and were instructed to draw a line under the last problem completed following each 1-min interval. The purpose of the current study was to determine whether Van Houten and Thompson's (1976) explicit timing procedures would increase problem completion rates and accuracy levels in African-American third-grade students.

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METHOD

Participants and Setting

Parental consent and students' assent for participation in this study were solicited for all African-American third-grade students in eight different classrooms in a rural Mississippi school district. From this pool, 44 students who attended school on days on which sessions were conducted participated in experimental procedures. These 44 students were divided into three groups. Group 1 had 12 students from two classrooms; Groups 2

and 3 each had 16 students from three classrooms. However, 8 students' data (4 each from Groups 2 and 3) were excluded from analysis because these students failed to follow directions consistently (e.g., left seat during math time, refused to do any computations on one or more sheets). All procedures were conducted in the students' assigned general education classrooms. Students who did not participate in the study engaged in other independent seat work while procedures were conducted. Students who participated worked at their assigned desks throughout the study.

Procedure

Three sessions were conducted during each school day across 3 consecutive days. Each participant was given a packet of three assignment sheets on each day. Each assignment sheet contained a total of 108 addition, subtraction, and multiplication problems, including two-digit plus one-digit (e.g., 58 + 9), two-digit plus two-digit (e.g., 67 + 86), two-digit minus one-digit (e.g., 87 − 5), and one-digit by one-digit (e.g., 6 × 7) problems. Problems were printed on both sides of sheets of paper (8.5 in. by 11 in.). Prior to beginning the study, each of the eight classroom teachers reviewed the assignments and reported that most of the students had acquired the skills necessary to complete each type of problem.

During each session, students were given exactly 4 min to work problems on each assignment sheet. Therefore, each day, students had 12 min allotted to complete problems from three different assignments. Sessions were led by one of four experimenters (i.e., a faculty member and three graduate students). To enhance standardization of procedures, experimenters were provided with written directions that outlined the procedures.

During baseline sessions, participants were oriented toward the appropriate assignment sheet and were instructed (a) to start when told to begin, (b) to complete as many problems as they could while still working accurately, (c) to work horizontally across the assignment sheet without skipping any problems, and (d) to hold their pencil up when told to stop. After using the blackboard to demonstrate working horizontally across the page, assignment packets were passed out (first session of the school day) or students were told to turn to the next assignment sheet (second and third session of the school day) and students were instructed to begin. During baseline sessions, students worked for 4 consecutive minutes; experimenters used wristwatches to covertly time sessions. Experimenters made no attempts to inform the students that they were being timed. Between sessions, experimenters spent about 30 s repeating instructions.

Explicit timing sessions were similar to baseline sessions except students were told that they would have a total of 4 min to complete as many problems as possible and that the experimenter was going to use a stopwatch to time them for 1-min intervals. The experimenter held up the stopwatch for all to see. Students were informed that after each minute had elapsed, the experimenter would tell them to stop. After being told to stop, students were instructed to circle the last problem they had completed and to hold their pencils up. Next, the experimenter reset the stopwatch and repeated the procedure three more times per session.

The primary experimenter scored the number of problems correct and the number of problems completed for each assignment. To collect interscorer agreement data, another experimenter randomly selected 25% of the assignment sheets and independently recorded the same data. Interscorer agreement was calculated for each assignment by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Across assignments,

interscorer agreement scores ranged from 88% to 100% for both problems completed and problems completed correctly. Average interscorer agreement was over 98% for both measures.

RESULTS AND DISCUSSION

Figure 1 shows that the mean number of problems completed and the mean number of problems completed correctly increased for each group immediately following the implementation of the explicit timing procedure. However, across all students, the increase in problems completed was larger than the increase in problems completed correctly. In effect, there was a decrease in the percentage of problems completed correctly.

Figure 2 displays the mean percentage of problems completed correctly (i.e., number correct divided by number complete and multiplied by 100%). Across all three groups, accuracy levels decreased. However, only Group 3 showed a decrease in accuracy levels that was inconsistent with baseline trend data immediately following the timing intervention. This suggests that the decreases in accuracy were not caused by the timing procedure. One plausible explanation for the decrease in accuracy is that, because no procedures were provided to address accuracy levels (e.g., contingencies, accuracy feedback), extinction of accurate responding may have occurred during baseline and explicit timing procedures. If this were true, then students who had not progressed far enough into the acquisition phase should have been more likely to experience a decrease in accuracy (Haring & Eaton, 1978). An exploratory analysis of current data was conducted to examine this hypothesis. The 36 subjects were divided into three ranked groups of 12 based on average baseline accuracy levels (i.e., highest 12 baseline accuracy, lowest 12 baseline accuracy, and middle 12 baseline accuracy levels). Three separate dependent *t* tests, one for each ranked group, showed no significant differences in mean baseline and intervention phase performance ($p < .05$). However, Figure 3 shows that the mean baseline levels decreased for the lower and middle accuracy levels, but the students who had the highest levels of baseline accuracy showed few mean changes across phases.

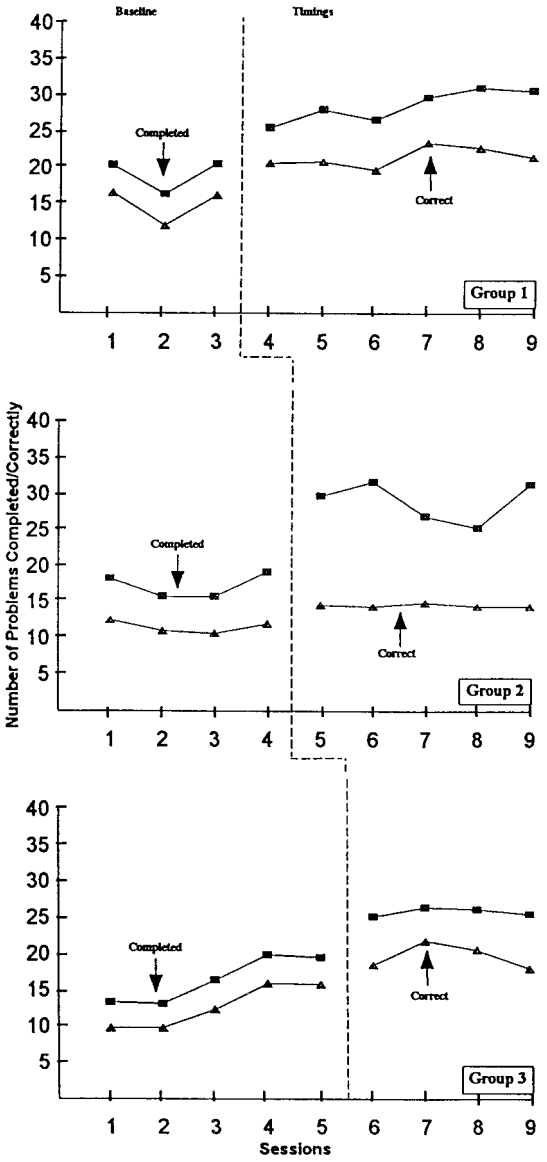

Figure 1. Mean number of problems completed and problems completed correctly for each session across groups.

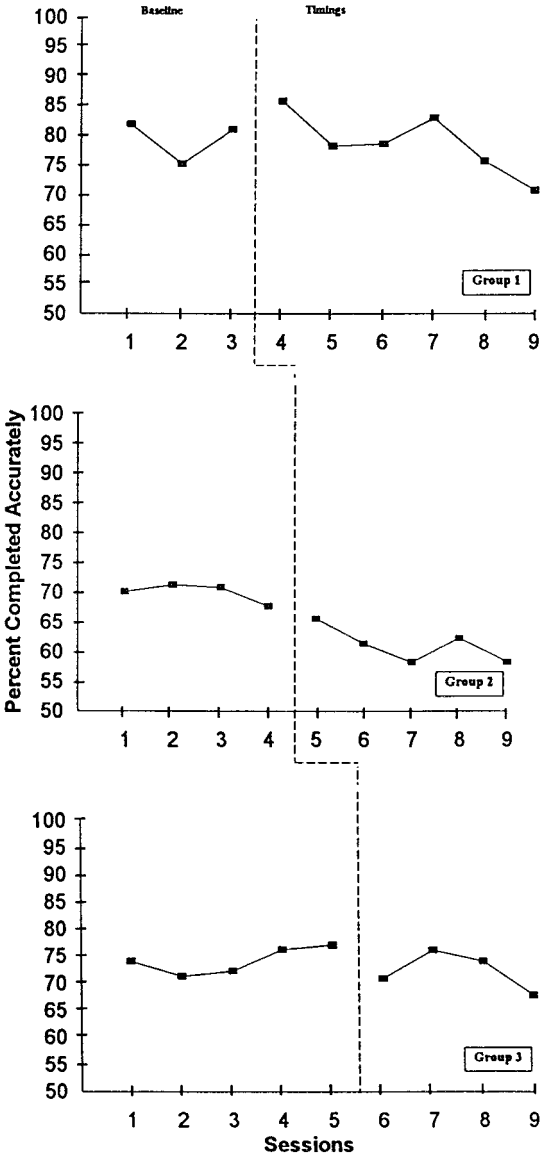

Figure 2. Mean accuracy levels (i.e., percentage correct) for each session across groups.

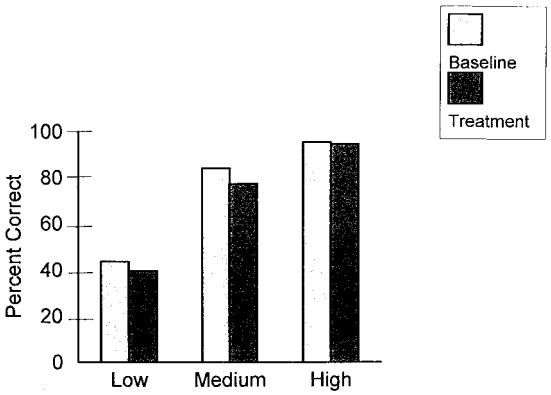

Figure 3. Mean percentage of problems completed correctly across phases for low-, middle-, and high-accuracy groups.

In the current study, the timing procedure appeared to serve as a stimulus event that occasioned increases in problem completion rates, but no procedures (e.g., contingencies, feedback, or accuracy instruction) were provided to address accuracy levels. Therefore, students still in the acquisition phase of skill development may have decreased their accuracy levels throughout the course of this investigation. Although increased levels of responding have been associated with increases in skills acquisition, maintenance, and fluency, these increases are unlikely to occur if responses are inaccurate. Therefore, educators who use timing procedures to increase rates of active responding should either ensure that students have obtained sufficient accuracy levels before implementing the timing procedures or supplement timing procedures with procedures that are designed to increase response accuracy, such as contingencies for accurate responding, public posting of accuracy levels, or immediate evaluation and feedback (Van Houten, Hill, & Parsons, 1975).

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